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Possible Photosensitivity of the Abdominal Saddlepatch Region of
Limenitis archippus Larvae (Lepidoptera: Nymphalidae)

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Abstract

This paper reports preliminary experiments testing whether or not the saddlepatch region of 2nd and 3rd instar (prediapause) viceroy larvae is photosensitive. The results of these experiments are equivocal, but they do not rule out this possibility. Covering the saddlepatch area of 2nd and 3rd instar larvae with non-toxic black (acrylic or enamel) paint failed to inhibit the facultative diapause responses of *L. archippus* larvae in most groups. However, pronounced detrimental effects (including high mortality) subsequently occurred in the experimental groups during later instars and at the time of pupation. These effects did not occur in either untreated or clear paint-treated control groups, suggesting that neuroendocrine effects are caused by masking the saddlepatch area of these larvae. Such effects are drastic enough to prevent the larval-pupal ecdysis in many individuals.

Temperate insects utilize photoperiod as an important environmental cue. Among various species, different life stages are capable of diapausing through the winter season (Wigglesworth, 1970; Beck, 1980). Among the nearctic admirals [*Limenitis* (*Basilarchia*) (Lepidoptera: Nymphalidae)], the 2nd and early 3rd instars are photosensitive. These half-grown larvae entrain to photoperiod over a four to seven day period ($25^{\circ}\text{C} \pm 2^{\circ}\text{C}$), and enter facultative diapause during late summer and autumn, in response to decreasing daylength (Clark & Platt, 1969; Hong & Platt, 1975; Frankos & Platt, 1976; Platt, 1984; Williams & Platt, 1987; Platt & Harrison, 1988). Diapause is accompanied by slowed larval growth and the construction of elaborate hibernacula (Edwards, 1884; Scudder, 1889; Weed, 1926; Klotz, 1951).

The physiology of insect diapause and its associated metabolism are complex (Lees, 1955; Harvey, 1962). The means by which Lepidoptera and other insects perceive and respond to changes in photoperiod are not well-understood, but in many species such responses involve endogenous rhythms (Beck, 1980; Saunders, 1982).

The individual ommatidia of adult insect compound eyes, as well as ocelli, and larval stemmata (equivalent to ocelli) often are specialized for receiving specific wavelengths of light (Goldsmith, 1961; Burkhardt, 1964; Silbergeld, 1979; Ichikawa & Tateda, 1982). However, the mechanisms for larval photoperiod responses in Lepidoptera remain essentially unknown. Cauterization experiments by Tanaka (1950a, b, c;

1951a, b) suggest that the larval stemmata are not involved in the diapause responses of the Chinese Tussar silkworm, *Antheraea pernyi* Guérin-Ménéville (Saturniidae).

In addition to stemmata, many young nymphalid and papilionid larvae possess a mid-abdominal, grayish-white, dorsolateral saddlepatch. In *Limenitis*, the saddlepatch is centered on the eighth abdominal segment above the primordial gonads. The dark paired gonads of male larvae are sometimes visible through the saddlepatch. The saddlepatch possesses a faint grayish-pink color and is thought to serve a cryptic function, making young larvae closely resemble bird droppings as they rest in a curled position on the upper surfaces of leaves and plant stems. This behavior and morphology provides an effective means of avoiding visually oriented vertebrate predators (mainly birds).

The saddlepatch may serve an additional function: photosensitivity of larval *Limenitis* is correlated with the appearance of this pale, dorsal abdominal patch. Reciprocal transfer experiments, first reported by Clark & Platt (1969) and later repeated by Platt (unpubl.) reveal that both the eggs and first instars do not entrain to photoperiod. These early stages do not respond to either longday or shortday photoperiods. The first instar larvae are entirely orange-brown in color. They lack the saddlepatches which appear following their first molt. I suspect that such saddlepatches may represent "cuticular windows" through which the larvae sense the environmental photoregime, in order to determine whether or not to diapause. Non-optic light reception causing photoperiod responses in Lepidoptera and other insects has been recorded by Lees (1955, 1960; Beck & Alexander (1964a, b, c); Callahan (1965); and Hinks (1975).

Materials and Methods

Laboratory strains of the viceroy, *L. archippus* Cramer, larvae were established from hibernacula collected in northern Maryland and on the UMBC campus. Larvae emerging from the hibernacula were reared on weeping willow foliage (*Salix babylonica* L., Salicaceae), in light-tight wooden photochambers (61x61x42 cm, inside dimensions) at room temperature ($25^{\circ}\text{C} \pm 2^{\circ}\text{C}$). Each chamber contained a 38.1 cm, 15 watt, G. E. fluorescent cool white bulb. Larvae were reared individually in labeled 7.6 cm white styrofoam cups covered with plastic bags held in place with rubber bands. The cups were enclosed in clear plastic shoe boxes lined with moist paper towels. Each cup was cleared of larval frass and provided with fresh food daily.

Adults obtained from these *L. archippus* larvae were bred by hand-pairing (Platt, 1969). Bred females were induced to oviposit on potted cuttings of *S. babylonica* covered by silk organza bags. The F_1 eggs and larvae that resulted from these crosses were used in the experiments.

Experimental larvae were reared on both longday (LD 20:4)

and shortday, either LD 13:11 (Tables 1 & 2) or 12:12 (Tables 3 & 4), photoperiod using the conditions described above. Eggs and first instar larvae were evenly divided into three groups as follows: I) untreated controls, II) treated controls (painted with clear paint), and III) experimentals (painted with black paint). Painting was not begun until the saddlepatches appeared on 2nd instar larvae. Larvae were repainted in dim red light after each molt, prior to the daily on-set of the photoperiod lights at 10 a.m. E.S.T. Painting was continued through the 5th instar, for larvae that exhibited direct development. Diapausing larvae remained painted even after the larvae had entered their hibernacula. An acrylic polymer water soluble non-toxic paint was used in the first series of experiments done in Maryland. The clear paint contained only the transparent plastisized base, whereas, the black paint contained a ferrous oxide pigment imbedded in the clear acrylic base. All painted larvae were able to molt freely during their larval stages.

With similar procedures, additional experiments were carried out at the University of Liverpool in England (Tables 3 & 4). In these later experiments, a shortday photoperiod of LD 12:12 was used, and non-toxic Humbrol black enamel and clear Polyurethane paints were employed in the masking procedures. The later experimental protocol closely followed that of the prior experiments. The artificial photophase on-set in Britain was correlated with 10 a.m. Greenwich mean time.

Results

In the initial studies all 45 larvae in the shortday photoperiod (LD 13:11) entered diapause at 3rd instar (Table 1), regardless of treatment group. Covering the saddlepatch of 2nd and 3rd instar larvae in shortday conditions with black acrylic paint failed to inhibit the diapause response. The untreated controls and both treated groups grew and molted normally, and required about three weeks to construct their hibernacula and enter diapause. However, among 51 treated larvae reared on longday photoperiod (LD 20:4), the mortality rate among black painted larvae was significantly higher than among the clear painted controls (Table 2). Mortality among the treated controls was similar to that of untreated larvae (16.0%). Among the experimental group, 23 of 36 larvae (63.8%) died at pupation (sum chi square d.f.=1 Yates= 69.25, $P < .001$). Twenty of 23 larvae died as prepupae. The remaining three died later as malformed chrysalids. None of the experimental group eclosed as adults.

Prior to pupation larval growth in both shortday and longday conditions was unaffected by the painting experiments. Six weeks after diapause the experimental shortday larvae were still alive when their hibernacula were opened. Thus, it can be inferred that the acrylic based paints were non-toxic to the larvae.

Results of my experiments done in Britain are shown in

Table 1. Results of "masking" the white abdominal saddlepatch area of 2nd and 3rd instar Maryland Viceroy larvae with an acrylic black paint prior to diapause (LD 13:11; 25°C $\pm$ 2°C), 1970 data.

Treatment	No. of larvae	No. diapausing	avg. Wt. mg	avg. No. days to diapause
untreated controls	12	11 ¹	21.5	20
treated controls	17	17	24.8	20
experimental larvae	18	17 ¹	29.0	24
Totals & Means	47	45	25.6	21.5

¹ One larva died in each group prior to 3rd instar.

Tables 3 and 4. The longday and shortday untreated controls (group I) either developed, or diapaused at 3rd instar as expected. The clear paint treated controls did likewise (group II), with $n = 6$ in each. Coating either the saddlepatch or the head stemmata with clear polyurethane paint produced no detrimental effects on the treated control larvae.

However, among the three experimental subgroups (III, A, B, and C) of longday experimental larvae coated with black enamel paint, mortality among 18 larvae ($n = 6$ per treatment) was 100%. Most mortality occurred between the 3rd instar and pupation, just as it had in the earlier experiments.

Eleven of these longday experimental insects died either as prepupae or pupae. In group III C, in which only the stemmata were painted, the head capsule remained attached to otherwise normally formed pupae in three cases. Microscopic examination of these pupae indicated that the problem was not simply a mechanical failure to shed the painted head capsules, but rather that the head region itself had not undergone metamorphosis. No pupal cuticle was found beneath the larval head capsules. A number of specimens of adult Lepidoptera (including two *Limnitis*) have been recorded, in which the head region remained larval (Hagen, 1876; Brewer, 1978; Stammenhaus, 1978; Platt, 1979).

Among 19 experimental shortday larvae (groups III A, B, and C) eleven died between the 3rd instar and the pupal stage (Table 4). All six larvae in group III A, which had the saddlepatch region covered with black enamel paint, died as larvae, with three of them (50%) developing beyond the diapause stage. Thus, there appears to be some inhibition of the diapause response in this subgroup, possibly as a direct result of masking the saddlepatch area. The black enamel paint appeared to provide a more solid and uniform mask than did the

Table 2. Growth of treated (painted) Maryland viceroy larvae exhibiting direct development in longday photoperiod (LD 20:4; 25° ± 2°C), 1970 data.

Treatment	No. of larvae	No. and % surviving ¹ (to pupa)	Expected No. Surviving	sum Chi sq. (d.f.=1) (Yates)
Treated controls (clear)	alive 25	21 (84%)	21.0	0.08
	dying	4 (16%)	4.0	(p = 0.77)
Experimental larvae (black)	alive 36	13 (36%)	30.24	69.25
	dying	23 ² (64%)	5.76	(p<.001)

¹ The survival rate for untreated *L. archippus* larvae (instars 1-3)= 0.84, and mortality= 0.16. The expected numbers were calculated using these values.

² 20 larvae died as prepupae, three as pupae.

water soluble acrylic paint used earlier. However, these results are inconsistent with those of group III B, in which six of seven larvae, having both their saddlepatch areas and stemmata painted black, formed hibernacula and diapaused in shortday photoperiod. Two of six larvae in group III C (having only the stemmata painted black) did likewise, but three others showed partial development beyond 3rd instar before dying, despite the shortday conditions to which they were exposed.

Although results of other experiments suggested that diapause termination occurred equally well under both shortday and longday photoregimes (Platt, 1984; per. obs.), I suspect that the 4th and 5th larval instars do remain photosensitive. Certain additional observations of mine support this contention: larvae reared either under continuous light or in complete darkness almost invariably died. Molting larvae and prepupae seem to be especially sensitive to photophase disturbance or alteration. Presumably this is because the diel hormonal neurosecretory rhythms influencing growth and development (mainly those involving brain hormone, juvenile hormone (JH), and ecdysone) remain unregulated, so that each separate secretory rhythm drifts out of phase with the others. Additionally, shifting photophase, or subjecting larvae to both artificial photoperiod and ambient cycles of differing lengths at the same time cause the larvae to exhibit viral-like symptoms, which I have termed "photoperiod disease". Death usually results from such treatments. Often, the grayish-white dorsolateral abdominal saddlepatches of these larvae become discolored, and turn a rusty orange-brown as these effects take place. Larval death usually is associated with molting (or the larval-pupal ecdysis) in such cases (Platt, per. obs.).

A few larvae that exhibited the above symptoms were sent to the USDA Insect Pathology Laboratory at Beltsville, MD for

Table 3. Growth of longday experimental and control groups of Maryland viceroy larvae (two F₁ broods, UMBC stocks) reared in Liverpool, England during May-June, 1976. (Longday = LD 16:8; 25° ± 2°C). SP= saddlepatches, S= stigmata.

Treatment	No. of larvae	No. & % dying	stages ¹ at death	No. Adults (A) or Hibernacula (H)
I. Untreated controls	6	1 (16.6%)	P	5(A)
II. Treated controls (clear)				
A. SP only	6	0	--	6(A)
B. SP & S	6	1 (16.6%)	3rd	5(A)
subtotals	18	2 (11.1%)	3rd, P	16
III. Experimental groups (black)				
A. SP only	6	6 (100%)	4th, 5th (3)	0
B. SP & S	6	6 (100%)	PP, P	
C. S only	6	6 (100%)	3rd, PP (5)	0
			5th (3)	0
			P(3) ²	
subtotals	18	18 (100%)	3rd, 4th, 5th (6), PP(6) P(4)	0

¹ stages: 3rd, 4th, 5th larval instars; PP= prepupa; P= pupa.

² head region of pupae remained larval (see text).

analysis, however, no pathogens were found in the larvae. Only a few yeast cells were present in the larval haemolymph following death, and an "environmental factor" was suggested as the probable cause of death.

Discussion and Conclusions

The black painted experimental larvae reared in longday photoperiod exhibited normal growth and initially formed typical prepupae. The prepupal stage in *Limnitis* usually lasts about 24 hours before ecdysis occurs. After about 12 hours the experimental larvae began to dehydrate, and then rapidly shrivelled and died. The black paint covering the saddlepatch was considered to be a probable cause of some physiological disorder inhibiting metamorphosis. Very likely, juvenile hormone (JH) titres remained high in the larval haemolymph, rather than shutting down as they do in normal larvae. If so, then the saddlepatch region quite likely served some photoreceptive

Table 4. Growth of shortday experimental and control groups of Maryland viceroy larvae (two F₁ broods, UMBC stocks) reared in Liverpool, England during May-June, 1976. (Shortday= LD 12:12; 25°C ± 2°C). (SP= saddlepatches; S= stemmata).

Treatment	No. of larvae	No. & % dying	stages ¹ at death	No. Adults (A) or Hibernacula (H)
I. Untreated controls	6	0	--	6 (H)
II. Treated controls				
A. SP only	6	0	--	6 (H)
subtotals	12	0	--	12
III Experimental groups				
A. SP only	6	6 (100%)	3rd (3), 4th, 0 5th (2)	
B. SP & S	7	1 (14.3%)	3rd	6 (H)
C. S only	6	4 (67%)	3rd, PP p ₂	2 (H)
subtotals	19	11 (57.9%)	3rd (6), 4th 5th (2), PP P	8 (H)

¹ stages: 3rd, 4th, 5th larval instars; PP= prepupae; P= pupae.

₂ head region of pupae remained larval (see text).

function. Similar mortality occurs when larvae are allowed to pupate in continuous light, without any diel photophase.

If the above hypothesis is correct, then these larval saddlepatches may function similarly to the white cuticular patches located between the antennae of diapausing pupae of *Antheraea* silkmoths (Saturniidae). These latter regions act as windows, allowing the insect brains to receive light stimuli through their dense cocoons (Shakhbozov, 1961; Williams & Adkisson, 1964; Williams et al., 1965). The abdominal saddlepatches persist in the later larval and pupal stages of *Limenitis*, where they possibly remain active in photoreception.

Hinks (1975) demonstrated that larvae of a number of arctiid, noctuid, and sphingid moths all possessed a bilateral segmental series of peripheral neurosecretory cells, located in all three thoracic segments, and in abdominal segments one through eight. He believed these single cells or small ganglion-like cell clusters functioned as neurohemal organs. Likewise, Beck & Alexander (1964a, b, c) have reported photoperiod-induced diel secretory rhythms that involved the hindgut hormone, proctodone, in mature larvae of the European corn borer, *Ostrinia nubilalis* (Hübner). In this species,

which lacks an abdominal saddlepatch pattern, the hormone released into the haemolymph subsequently stimulated the insect brain.

Beck (1980) noted that photoperiod entrainment of diel behavioral rhythms that involved such activities as flight, sexual behavior, and oviposition, as well as larval locomotion and feeding, depended on the duration of the scotophase, rather than the photophase per se. In all, he recorded 15 species of Heterocera, representing nine families of Lepidoptera. However, all species were nocturnal moths. Diurnal Lepidoptera, such as all species of temperate *Limnitis*, may respond to the photophase itself. Such behavioral activities as hibernaculum construction, larval locomotion and feeding, and pupation often occur in the light phase of the diel cycle. The results in this paper suggest a photosensitive role of the saddlepatch in *Limnitis*. Additional experiments are planned to further test the possibility that the pale mid-abdominal saddlepatch of admiral butterfly larvae possibly may be photosensitive.

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Observations on *Gnorimella maculosa* (Coleoptera: Scarabaeidae:
Cetoniinae)

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Abstract

Gnorimella maculosa is considered rare in collections. During 1988, ten specimens were collected throughout Maryland. This species may not be as rare as is indicated from collections.

Gnorimella maculosa (Knoch) is considered rare in collections (Hinks, 1957, 1958). Staines (1986) reported this species from Charles, Howard, Montgomery, and Prince George's Counties. Glaser (1987) recorded no additional localities. There is little published information on the biology and life history. Ritcher (1945) states that cetoniid larvae feed on organic matter in soil, decaying wood or trash, and other debris accumulated in the hollows of trees. Hinks (1957) collected specimens flying around *Cornus rugosa* Lam. (Cornaceae); he also summarized the following flower records for adults: *Liriodendron tulipifera* L. (Magnoliaceae), *Rubus* sp., *Crataegus* sp., *Malus* sp. (Rosaceae), and *Rhus* sp. (Anacardiaceae). Staines (1986) recorded specimens collected from dead red maple (*Acer rubrum* L., Aceraceae), eastern redbud (*Cercis canadensis* L., Leguminosae), and flowering dogwood flowers (*C. florida* L.).

During 1988, ten specimens of *G. maculosa* collected in Maryland were seen by the author (unless noted the specimens are in the collection of the author):

- Anne Arundel Co.: Edgewater, 27-30/V/1988, taken in blacklight, two specimens.
Baltimore Co.: Soldiers Delight Natural Area, 14/VI/1988, taken in a southern pine beetle pheromone trap.
Cecil Co.: Elk Neck State Forest, 2/VI/1988, taken in a southern pine beetle pheromone trap.
Garrett Co.: Accident, 5/VII/1988, taken in an Allison-Pike trap, four specimens in the Maryland Department of Agriculture Collection.
Somerset Co.: Princess Anne, 9/V/1988, taken in a southern pine beetle pheromone trap.
Worcester Co.: Girdletree, 17/V/1988, taken in a southern pine beetle pheromone trap.

These records indicate that *G. maculosa* is more common than indicated from collections. The species appears to frequent wooded areas and is a strong flier. The southern pine beetle pheromone traps contained frontalin plus loblolly pine

turpentine.

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Book Review- Acarology- Mites and Human Welfare. T. A. Woolley. John Wiley & Sons, New York, 1988. 484 pp. \$57.50

As most of the general texts on the Acari are out of print, this book is a welcome addition. Part I is an introduction to acarology, beginning with an overview providing general information about the Acari, their ecological locations, and the major ways they affect people. Chapter 2 discusses the relationship of mites and other arachnids, and provides keys to the subclasses and orders of the Arachnids.

Part II focuses on the anatomy, size, integument, chaetotaxy, internal morphology, feeding habits, reproduction and pheromones.

Part III is on classification. Each of the two cohorts (Parasitiformes, Acariformes) and seven orders (Opilioacarida, Holothyrida, Gamasida, Ixodida, Actinedida, Astigmata, Oribatida) are characterized. Many families are described briefly, and exemplified.

Part IV delves into the history of acarology and the ecology of mites (Chapter 23). References are provided at the end of each chapter.

The author has provided a superb overview of the subject of Acarology, however, this book is not intended as a systematic text.

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Additional records on Maryland Silphidae (Coleoptera)

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Abstract

Additional county records are presented for *Necrodes surinamensis*, *Silpha americana*, *Dicoptoma inaequale*, *D. novaboracense*, *Nicrophorus orbicollis*, *N. pustulus*, *N. sayi*, and *N. tomentosus*. *Nicrophorus defodiens* is characterized and the key in Staines (1987) is amended to include this species.

Staines (1987) reviewed the Silphidae species known to occur in or near Maryland. After that article was submitted for publication in 1984, an excellent work on Canadian Silphidae was published by Anderson & Peck (1985). In this work there were several generic changes affecting common Maryland species plus range maps of all North American species.

Since 1984, collecting in Maryland has yielded the following new county records and one species that was not included. The museums and collections where the specimens are deposited are noted by the following abbreviations in the text: USNM, National Museum of Natural History, Smithsonian Institution; FSCA, Florida State Collection of Arthropods; MDA, Maryland Department of Agriculture; CLS, C. L. Staines, Jr.

Necrodes surinamensis (Fab.): Caroline Co.: Preston, 8-VIII-1988 (FSCA). Charles Co.: Indiantown, 19-VII-1988 (USNM). Dorchester Co.: Rhodesdale, 28-III-1989 (FSCA). Somerset Co.: Princess Anne, 7-VIII-1988 (USNM, FSCA). Talbot Co.: Seth State Forest, 29-VI-1988 (USNM).

Silpha americana L.: Talbot Co.: Seth State Forest, 29-VI-1988 (USNM).

Dicoptoma inaequale (Fab.): Talbot Co.: Seth State Forest, 29-VI-1988 (USNM, FSCA).

D. novaboracense (Forster): Talbot Co.: Seth State Forest, 29-VI-1988 (USNM, FSCA).

Nicrophorus orbicollis Say: Calvert Co.: St. Leonard, 19-V-1989 (FSCA). Caroline Co.: Denton, 14-V-1989 (FSCA). Dorchester Co.: Reliance, 16-V-1989 (FSCA). Queen Anne's Co.: Ingleside, 21-V-1989 (FSCA). Somerset Co.: Princess Anne, 25-VII-1988 (FSCA).

N. pustulatus Hershel: Caroline Co.: Harmony, 20-V-1989 (FSCA). Carroll Co.: Eldersburg, 19-V-1989 (FSCA). Charles Co.: Waldorf, 21-V-1989 (FSCA). Dorchester Co.: Rhodesdale, 28-III-1989 (FSCA). Howard Co.: Woodbine, 6-VII-1988 (USNM, FSCA). Queen Anne's Co.: Ruthsburg, 15-VIII-1988 (USNM).

N. sayi Laporte: Howard Co.: Clarksville,

8-20-XI-1979 (CLS). Talbot Co: Seth State Forest, 29-VI-1988 (USNM).

N. tomentosus Weber: Carroll Co.: Hampstead, 24-VI-1988 (USNM). Talbot Co.: Seth State Forest, 29-VI-1988 (USNM).

N. defodiens Mannerheim

Description: Pronotum quadrate, with wide lateral and basal margins. Antennal club entirely black. Metasternal pubescence dense, yellow, metepimeron glabrous. Hind tibia straight. Elytral pattern variable. 12 to 18 mm. in length.

Ecology: *Nicrophorus defodiens* is found primarily in forests. Adults do not bury carcasses but conceal them under leaves and other debris (Anderson & Peck, 1985).

Distribution: Transcontinental in Canada; California, Washington, Oregon, Idaho, Montana, Wyoming, and Utah on the west coast; on the east coast Maine west to North and South Dakota, south to North Carolina (Anderson & Peck, 1985).

Specimens examined: Garrett Co.: Bittering, 1-VII-1988, 29-VII-1988 (USNM, FSCA, MDA, CLS). A total of 27 specimens of this species were captured. This species can be keyed with the following modifications to the *Nicrophorus* key in Staines (1987):

- 6. Three terminal segments of antenna black.....6a
- Three terminal segments of antenna red.....7
- 6a. Base of elytral epipleuron orange, with prebasal black spot.....vespilloides
- Base of elytral epipleuron entirely black.....defodiens

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The Genus *Meropleon* Dyar (Lepidoptera: Noctuidae,
Amphipyridae) in Maryland

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Abstract

Four years of continuous collecting have shown that two species of the genus *Meropleon* are resident in Maryland. This is the first report of the occurrence of *M. titan*, and confirms the presence of *M. diversicolor*. Blacklight trapping near marshy habitats during September and October may reveal the presence of one or more of the remaining species.

"*Meropleon* is a distinct and isolated genus of five species endemic to eastern North America." Of the five described species, only one, *M. diversicolor* (Morrison), is recorded from Maryland. This record is based on a single specimen in the collection of the National Museum of Natural History (NMNH), Smithsonian Institution, and is labeled "Md." (Ferguson, 1982).

Nightly collecting with UV lights from 1985 to 1988 at Southaven, Anne Arundel County, and at other locations in the state, has confirmed the presence of *Meropleon* in Maryland.

Meropleon titan Todd (Hodges # 9426)

Meropleon titan was known only from South Carolina, Mississippi, Missouri, and north central Texas (Ferguson, 1982). The flight period is 24 September to 10 October. One specimen reared from larvae found boring in corn (*Zea mays*) 20 June 1957 emerged as an adult 26 September (Ferguson, 1982).

Two specimens of *M. titan* were collected 29 September and 1 October 1986 at Southaven (Stevenson, 1987). Since that time an additional specimen collected 24 September 1985 (previously misidentified), seven from 27 September to 16 October 1987 and seven from 18 September to 16 October 1988 have been identified from the same locality. An additional specimen of *M. titan* was collected at Edgewater, Anne Arundel County, on 26 September 1988 by C. L. Staines. This locality is also on the South River, about one mile from Southaven. These records extend the distribution of *M. titan* from South Carolina to tidewater Maryland, a distance of about 600 miles. The collection site at Southaven is within 200 feet of tidal water of the South River, an inlet of the Chesapeake Bay. Very little marsh grass has survived the onslaught of "civilization" and corn is no longer cultivated locally.

A total of 18 specimens (see Table 1), fifteen male and three female *M. titan*, have been collected between 18 September and 16 October during the four seasons 1985 through 1988. These are more than are known from any other locality

(Ferguson, pers. comm.). Intensive collecting at the right season, particularly in tidewater areas, may well reveal additional colonies. Five specimens have been deposited in the NMNH collection.

Meropleon diversicolor (Morrison) (Hodges # 9427)

Meropleon diversicolor was first taken at Southaven on 27 September 1985. Another specimen was taken near the South River on 13 August 1988 by John D. Glaser. The only eastern shore record is 24 September 1986 at Quaker Neck Landing, Kent Co.. Eleven other recent specimens have the following data (number of specimens noted in parentheses): Harford Co.— Otter Pt. Creek, 4 September 1987 (1); Garrett Co.— New Germany State Park, 21 September 1988 (1); Glades of Cherry Creek, 9–29 September 1988 (5); Cunningham Swamp, 24 August to 10 September 1988 (4).

Meropleon diversicolor may be distributed throughout the state as these sites extend from the eastern shore (Kent Co.), in the tidewaters of the Chesapeake Bay to the mountains of westernmost Garrett County. The flight period in Maryland is mid-August to the end of September (see Table 1), peaking the last two weeks of September. This peak is two weeks earlier than *M. titan*.

Meropleon ambifuscum (Newman) (Hodges # 9428)

No record of *M. ambifuscum* is known from Maryland. However, its known distribution is the eastern United States from Connecticut and Michigan south to South Carolina, Mississippi, and Arkansas (Ferguson, 1982). This suggests that it should occur in Maryland. Specimens should be checked carefully because of possible confusion between *M. diversicolor* and *M. ambifuscum*.

Meropleon cosmion Dyar (Hodges # 9425)

Ferguson (1982) did not record *M. cosmion* north of North Carolina. Eight specimens of *M. cosmion* were collected during the period 2–18 October 1988 in Burlington, Atlantic, and Cape May Counties, New Jersey by Dale F. Schweitzer (Schweitzer, pers. comm.). The host plant appears to be sugarcane plumegrass, *Erianthus giganteus* (Gramineae). *Erianthus giganteus* is common in swamps and moist soil on the coastal plain of Maryland. Blacklight trapping near growths of this grass during the first two weeks of October will undoubtedly establish the presence of this moth in Maryland.

Table 1. Blacklight collection of *Meropleon* in Maryland (1985-1988). JDG= John D. Glaser; CLS= C. L. Staines; HGS= H. G. Stevenson.

<u>Species</u>	<u>No. Specimens</u>	<u>Location</u>	<u>Dates</u>
titan	17 (HGS)	Anne Arundel Co.	18 Sept.- 16 Oct.
	1 (CLS)	Anne Arundel Co.	26 Sept.
diversicolor	1 (HGS)	Kent Co.	24 Sept.
	1 (JDG)	Harford Co.	4 Sept.
	1 (JDG)	Anne Arundel Co.	13 Aug.
	1 (HGS)	Anne Arundel Co.	27 Sept.
	10 (JDG)	Garrett Co.	24 Aug.- 29 Sept.

Meropleon cinnamicolor Ferguson (Hodges # 9428.1)

Discovery of this species in Maryland is a remote possibility as it has never been found anywhere other than the type locality on the south side of the South Santee River, South Carolina (Ferguson, 1982). Collections from the tidewater salt marshes near the mouth of the Bay during October and November should be inspected carefully for this species.

Summary

Of the five described species of *Meropleon*, two (*M. diversicolor* and *M. titan*) have now been collected in Maryland. *Meropleon diversicolor*, previously known from a doubtful specimen, appears to be distributed statewide. Limited experience indicates a larger population in the western mountain bog habitats. *Meropleon titan* is a resident of tidewater Maryland, at least in the headwaters of the South River, as evidenced by its appearance each year for the past four years. *Meropleon ambifuscum*, if here, would be expected west of the Chesapeake during October and November. *Meropleon cosmion* may well exist in local colonies in coastal areas. *Meropleon cinnamicolor* should be thought of as a remote possibility in tidewater Maryland salt marsh habitats.

My special thanks to D. C. Ferguson, USDA, SEL, for criticism and suggestions in preparing this paper.

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Tidewater Maryland- Central Mississippi Lepidoptera

Stevenson (1988a, b, c) reported all five species of *Metaxaglaea* (Lepidoptera: Noctuidae), *Dasychira atrivenosa* (Palm) (Lepidoptera: Lymantriidae), and *Xestia bollii* (Grote) (Lepidoptera: Noctuidae) from Tidewater Maryland. All of these except *Metaxaglaea inulta* (Grote) have been taken in central Mississippi. The records are summarized below:

- M. *viatica* (Grote) (Hodges No. 9944): 150 specimens. Hinds, Warren, and Rankin Cos. October to March.
- M. *semitaria* (Franclemont) (Hodges No. 9945): 2 specimens Vicksburg, Warren Co. 31 December 1981; Pearl, Rankin Co. 26 December 1970.
- M. *australis* Schweitzer (Hodges No. 9945.1): 2 specimens. 29 January 1981 and 18 November 1981. Vicksburg, Warren Co.
- M. *violacea* Schweitzer (Hodges No. 9945.2): 7 specimens, all Vicksburg, Warren Co. 28 December 1981, 6 January 1982, 17 February 1982, 3 February 1984.
- D. *atrivenosa* (Hodges No. 8299): 19 specimens, all Bovina or Vicksburg, Warren Co. 1 May, 2 June, 2 July, 4 August, 9 September, 1 October.
- X. *bollii* (Hodges No. 10956): 8 specimens, all Hinds and Rankin Cos. 1 March, 1 October, 6 November.

Metaxaglaea viatica known to Stevenson from a single specimen, is common in central Mississippi, the others are not common either in Tidewater Maryland or central Mississippi.

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- Stevenson, H. G. 1988c. *Xestia bollii* (Grote) (Lepidoptera: Noctuidae: Noctuinae) in Tidewater Maryland. MD Entomol. 3(2):53-54.

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Book Review- Silent Spring Revisited. C. J. Marco, R. M. Hollingworth, and W. Durham (eds.). American Chemical Society, Washington, D. C. 1987. 214 pp. \$17.95.

That Rachel Carson's book Silent Spring was controversial is unrefutable. That all the predictions and statements were correct is questionable. That the book is important is a fact. Silent Spring Revisited is based upon a symposium organized to "address the issues that Rachel Carson raised and to focus on their pertinence for the past, present, and future". The contributors provided an excellent cross-section of opinions on all sides of the issues- though the bias of the authors was evident.

Shirley Briggs, of the Rachel Carson Council, Inc., starts with a discussion of the vision and legacy of Ms Carson. Ms Briggs discusses Carson's motives, the reaction to Silent Spring, and then goes on to the comprehensive view. She states that "we at Rachel Carson Council have yet to be shown a valid example" (of inaccuracies or mistakes). G. K. Kohn of Zoecon Corp., in chapter 10 points out some inaccuracies, though recognizing Carson's achievements. Kohn's chapter is an excellent balance of the conflicting values of a pragmatic approach to agricultural productivity and the preservation of the environment. John Moore of EPA reviews the evolution of government regulations. He states that "the extensive requirements for current regulation do not always provide clear insight as to appropriate action. For example, the technical capability to routinely analyze in parts per million, billion, trillion or quadrillion clearly surpass the toxicologists' and other scientist's ability to confidently interpret human or environmental risk". Unfortunately, EPA gets blamed for not doing enough by environment zealots and for being over zealous by the producers and users of pesticides. It may be of interest to note that the National Agricultural Chemical Association estimates the cost and time of developing a pesticides, from test tube to the market, to be \$40 million and 8 years. Most of this is to fulfill EPA testing requirements.

C. F. Wilkinson of Cornell University continues the discussion in a chapter on the science and politics of pesticides. He very succinctly states "For the last decade and a half emotional belief, often verging on hysteria, has existed in the United States that society is being slowly poisoned by pesticides and other products of modern chemical technology. Despite the facts that we live longer and generally enjoy a much better quality of life than at any other time in our history, we have become a society consumed with fear and obsessed by the risks in our lives".

Chapters 4-7 assess the toxicity of pesticides to aquatic organisms (by Nimo, Coppage, Pickering, and Hanson of EPA), the impact of pesticides on ground water contamination (by Carsel and Smith of EPA), and the impact of pesticides on bird populations (by R. J. Hall of Fish and Wildlife Service). To

quote Nimo, et al. "while ridding the world of weeds, weevils, and webworms/ Be careful of fins, fur, and feathers".

J. E. Davis and R. Doon in chapter 7 review the human health effects of pesticides and discuss acute pesticide poisoning, including suicides; cancer risk; residues; resistance; and disposal. The beneficial aspects of pesticides in relation to public health are neglected. Rosen and Grech present the evaluation and impact of analytical chemistry of pesticides.

Virgil H. Freed of Oregon State University, in chapter 9, covers the global use of pesticides and concerns. Freed points out that despite the continuing and spreading controversy over the use of pesticides, the use of such chemicals has increased annually by 4-5% on a global basis since the publication of Silent Spring. Most of the pesticides are used by developed nations. He mentions a study in which pesticide poisoning was examined in a number of countries. He estimates a rate of 2.9-4.8 per 100,000 persons, with a mortality rate of 5.5%. This comes to 0.16-0.26 persons per 100,000. If this figure is compared to the worldwide morbidity and mortality for malaria, I believe most developing nations would consider the benefit far greater than the risk.

G. K. Kohn presents the other side of the coin in chapter 10, agriculture, pesticides, and the American chemical industry.

David Pimentel of Cornell University, in chapter 11 questions "is Silent Spring behind us?". He starts with "Fewer pesticides problems during the past two decades" and then follows with "Increased pesticide problems during the past two decades". His figures on pesticide effects on crops seem to be at odds with Kohn's comments. Pimentel estimates a negative impact on crops of about \$70 million annually. Kohn states that the additional wealth created by technology to be \$9,125,000,000. Pimentel states that 37% of all crops is lost annually to pests in spite of the combined use of pesticidal and non-chemical controls. If this is correct, what would it have been without the use of agrochemical technology? He concludes that pesticides will continue to be effective pest controls but the challenge now is to find ways to use them judiciously to avoid many of the environmental hazards and human poisonings that exist today.

Marco, et al. conclude the volume with an overview of the symposium. They point out that Silent Spring lead society to evaluate the new technologies in terms of risk versus benefits. Whereas lower levels of pesticides can now be detected, the true significance of these small amounts of pesticide residues is often quite uncertain. Toxicity evaluation is a complex process with great uncertainties, and it does not provide answers that are nearly as precise as the analytical techniques. The diverse opinions and opposing views between manufacture-user and environmentalist are clearly seen in the chapters of this book. There are fewer farmers and less labor available, yet more mouths to feed, therefore there seems no likelihood of completely

eliminating chemical controls in the near future. Rachel Carson was right in many respects, and in fewer respects she was wrong. Nature, not just humans generates its share of carcinogens and other poisons. Nature and humans both use chemicals to their own advantage. The human life span is increasing and birds still sing. What Rachel Carson accomplished was to set in motion a philosophy of using all tools in controlling pests, not relying exclusively on chemicals.

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VOUCHER SPECIMEN POLICY

The Council on Collections of the Association of Systematics Collections has recommended the establishment of voucher specimen policies for journals which do not currently have such policies. A voucher specimen is an organism preserved to document published or unpublished data. Authoritatively identified voucher materials should be routinely designated to document the identity of organisms involved in studies. Voucher specimens ensure the credibility and endurance of research results because they document the identity of studied organisms. Authors publishing in the Maryland Entomologist are urged to deposit voucher specimens in recognized insect collections to document their research, and to cite the place of deposit in publications relating to the research.

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Observations on Two Beetles (Coleoptera) Feeding on *Rumex*
(Polygonaceae) in Maryland with a Review of the Literature

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During May, 1989, larvae of two species of Coleoptera were collected feeding on *Rumex crispus* L. (Polygonaceae). Both species were reared in outdoor cages for adult emergence. Larvae, pupae, and adults have been deposited in the U. S. National Museum. Some limited no-choice feeding tests were conducted to determine potential host plant range.

Hypera eximia (LeConte) (Curculionidae)

Larvae of this species were collected on 8 May 1989 in Vienna (Dorchester Co.). The infested plants were found in low areas along the margins of wheat fields (*Triticum aestivum* L.). The first pupae were observed on 22 May. Pupae were found in the soil, in leaf debris, and on the sides of the cage. The last instar larva spins a tough, flexible, yellowish-orange, silken cocoon. Adults remain in the cocoon to harden for about 24 hours after emergence.

Recorded host plants for *H. eximia* are *Rumex orbiculatus* Gray (Popenoe, 1877 as *britannica*); *R. altissimus* Wood, *R. crispus*, and *R. obtusifolius* L. (Puttler et al., 1973); and *Polygonum* sp. (Anderson, 1971). In no-choice feeding tests larvae would feed on *R. acetosella* L., *R. altissimus*, *P. arifolium* L., and *P. pennsylvanicum* L. (Polygonaceae). Larvae would not feed on *Plantago major* L. (Plantaginaceae).

O'Brien and Wibmer (1982) record the known distribution of *H. eximia* as Illinois, Indiana, Texas, Colorado, Iowa, Kansas, Missouri, Nebraska, and Manitoba. Anderson (1971) recorded the species from Maryland when he described the larva.

Gastrophysa cyanea Melsheimer (Chrysomelidae)

Adults, larvae, and eggs of *G. cyanea* were collected on 26 May 1989 in Brandywine (Prince George's Co.). A female collected in copula laid an egg mass the night of 26-27 May. A field-collected egg mass hatched 29 May. The egg mass laid in captivity hatched 31 May. The first pupae were observed on 29 May. The first adults were collected 4 June.

Force (1966) conducted feeding tests for larval and adult host plants of *G. cyanea*. Larval feeding was observed on: *Rumex crispus*, *R. pulcher* L., *R. californicus* Rech., *R. hymenosephalus* Torr., *R. acetosella*, *Polygonum affine* D. Don, *P. aviculare* L., *P. capitatum* Buch.-Ham., *P. cuspidatum compactum* Hook. (as *reynoutria*), *Fagopyrum esculentum* Moench., and *Muehlenbeckia* sp.

(Polygonaceae). In no-choice feeding tests larvae would feed on *P. arifolium* and *P. pennsylvanicum*.

The larva of *G. cyanea* was illustrated in Boving & Craighead (1931). Howard et al. (1982) published a photograph of an egg mass.

Parasitoids emerged from *G. cyanea* pupae. These were identified as *Microctonus gastrophysae* (Ashmead) (Hymenoptera: Braconidae). This parasitoid attacks *G. cyanea* and *G. viridula* (DeGeer) and has been reported from the District of Columbia, South Carolina, and Virginia (Marsh, 1979). Voucher specimens have been deposited in the U. S. National Museum.

Acknowledgements

We would like to thank E. J. Ford for the identification of the adult *Hypera eximia* and P. M. Marsh, Systematic Entomology Lab., for the identification of *Microctonus gastrophysae*.

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The genus *Spragueia* Grote (Lepidoptera: Noctuidae, Acontiinae)
in Tidewater Maryland

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Abstract

Spragueia apicalis and *S. dama* are reported from Maryland for the first time.

The genus *Spragueia* contains twelve species in north America north of Mexico (Hodges et al., 1983). In the U.S. it is a southern and southwestern genus with only one species, *S. leo*, recorded north of Virginia.

Daily collection at U-V light traps for five years has disclosed the presence of two additional species—*S. apicalis* and *S. dama* at Southaven, Anne Arundel Co. I also report their collection at other locations and speculate the possible presence of *S. onagrus*.

S. leo (Guenée) (Hodges #9127)

Spagueia leo, the Common *Spragueia*, was first recognized 14 August 1987 when a single specimen was taken. Numerous specimens were collected from 23 June to 1 September 1988 and 7 July to 12 September 1989 at Southhaven, Bivalve, Wicomico Co., by Mark J. Rothschild (MJR) and Battle Creek Cypress Swamp, Calvert Co. (BCCS) by park personnel. Glaser reports its occurrence west to the piedmont (J. D. Glaser, pers. comm.).

S. apicalis (Herrich-Schäffer) (Hodges #9131)

Spagueia apicalis, the Yellow *Spragueia* is listed in Forbes (1954) as *Helicontia apicella* (Grote). Forbes notes its range as "Southern States to South America, north in August and September to Oconee, Illinois, Missouri and North Carolina." Covell (1984) states its range as "Va. to Fla." with dates Aug.-Sept. northward; Feb.-Nov. in Fla. and its food as Broom-Snakeroot (*Gutierrezia sarothrae* (Pursh) Britt. & Rusby, Compositae). He also notes that the North American subspecies is *S. apicalis apicella* (Grote). While Holland (1903, pl.29:56) illustrates the female only, Covell (1984, pl.30:10 and 14) gives excellent pictures of both male and female which differ considerably.

The first specimen is a female collected at Edgewater 7 June 1989 by C. L. Staines, Jr. and a second, a male, 17 July at Southhaven both in Anne Arundel Co. An additional female was taken 7 September at Battle Creek Cypress Swamp in Calvert Co.

Inasmuch as two of the specimens were taken before August it is interesting to speculate that it is a rare resident rather than a "stray" and will be found in proper plant

association. However, some other host will probably have to be identified as *G. sarothrae* is not known from Maryland but ranges from "SW Canada and western U.S. to northern Mexico" (Hortus III). The host may be a closely related *Eupatorium* such as *E. rugosum* Houtt., the white snakeroot, which is found in tidewater Maryland.

S. dama (Guenée) (Hodges #9122)

Covell (1984) gives the range of this species as "Ky. and N.C. to Fla.". First collected and recognized at Southaven 3 August 1989, additional specimens have been taken August 19, 22, 23 and 24. A specimen was collected 20 August at Edgewater, Anne Arundel Co. (CLS) and four at Bivalve, Wicomico CO. (MJR) 26 and 27 August. Four specimens were trapped at Battle Creek Cypress Swamp 23 August to 7 September.

Seventeen specimens (nine female) of *S. dama* have been collected in Anne Arundel, Calvert, and Wicomico counties in tidewater Maryland between 3 August and 12 September. *Spragueia dama*, the Southern *Spragueia*, is quite distinctive in pattern and easily recognized. However, it seems to be rare on a basis of about ten *leo* to one *dama*. On several occasions both species have been taken in the same trap the same night.

This is the first report of *S. dama* in Maryland.

S. onagrus (Guenée) Hodges #9126

Spragueia onagrus, the Black-dotted *Spragueia*, ranges from "N.C. to Fla., west to Miss. April-Sept. Common. Food: Chinquapin and field corn" (Covell, 1984). This species is also distinctively marked, however, in Holland (1903, pl. 29.57), *leo* is shown but identified as *onagrus* which can be a cause of confusion. In Covell (1984, pl. 30.16) *onagrus* is shown properly. For additional illustration of *Spragueia* species see Kimball (1965).

This species probably occurs in tidewater Maryland but it will require consistent trapping to find. As with *dama*, tidewater Maryland may be at its extreme range. Given the amount of field corn grown in this area as well as the presence of Chinquapin (Eastern Chinquapin *Castanea pumila* L. (Mill.), Fagaceae) it should be found here.

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Table 1. Blacklight collections of *Spragueia* in Maryland (1987-1989)

<u>Species</u>	<u>No. Specimens</u>	<u>Location</u>	<u>Dates</u>
dama	6 (HGS)	Anne Arundel Co.	3 Aug.-12 Sept.
	3 (CLS)	Anne Arundel Co.	22-28 Aug.
	6 (BCCS)	Calvert Co.	23 Aug.-18 Sept.
	4 (MJR)	Wicomico Co.	26-27 Aug.
leo	common	all localities	23 June-20 Sept.
apicalis	1 (CLS)	Anne Arundel Co.	7 June
	1 (HGS)	Anne Arundel Co.	17 July
	1 (BCCS)	Calvert Co.	7 Sept.

BCCS= Battle Creek Cypress Swamp; MJR= M. J. Rothschild; CLS= C. L. Staines; HGS= H. G. Stevenson

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A Bibliography of New World Hispinae (Coleoptera: Chrysomelidae)

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Abstract

A bibliography on the New World Hispinae from 1767 to 1988 is presented. Some literature from 1989 is included.

The New World Hispinae are poorly known. The literature consists of scattered species descriptions, faunal lists, and a few biological notes. Most of the literature is in European or South American journals, which are difficult to find. The purpose of this article is to list all articles known to the authors as dealing with New World species. No attempt has been made to check all of the agricultural experiment station reports and similar journals for mention of Hispinae. Several articles concerning New World species released as biological control agents against weeds in other parts of the world are included because of the added biological information obtained. The authors would appreciate copies of any additional articles on Hispinae which are not listed.

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Status of *Rhinocyllus conicus* (Coleoptera: Curculionidae) in Maryland

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Abstract

The distribution and abundance of *Rhinocyllus conicus* in Maryland were determined in a survey of eight counties. This beneficial weevil was introduced into Maryland in 1975 as part of a classical biological control program on *Carduus* spp. thistles. Large numbers of *R. conicus* were commonly found infesting *C. thoermeri*, and to a lesser extent *C. acanthoides*, in areas with high thistle populations. In counties with scattered populations of thistles, *R. conicus* was frequently absent. No significant decline in thistle populations was detected at selected sites where *R. conicus* and other beneficial insects were present. However, surveying these sites began eleven years after *R. conicus* was released, and the sites suffered constant disturbance from mowing and spraying.

A seed destroying weevil, *Rhinocyllus conicus* (Froelich) (RC), was first introduced into Canada from Europe in 1968 for the control of musk (= nodding) thistle, *Carduus nutans* L. and *C. thoermeri* Weinm. (Harris and Zwolfer 1971). Subsequent releases were made in 1969 in Virginia and Montana (Surles et al. 1974, Hodgson and Rees 1976).

RC was released in Maryland in 1975 and reported as established in 1978 (Batra 1980). Since then, there have been no extensive studies on RC in Maryland. The present paper reports on the current distribution and abundance of RC in Maryland.

Materials and Methods

Distribution and abundance of RC. Eight Maryland counties were sampled for the presence of RC in 1988: Anne Arundel, Baltimore, Carroll, Frederick, Harford, Howard, Prince George's, and Washington. However, 86% of all sample sites were in the "thistle-belt" counties of Carroll, Frederick, and Washington. Each county was divided into five, square-mile quadrats, with a single sample site in each quadrat. A suitable sample site was one that was infested with either musk (*C. thoermeri*) or plumeless (*C. acanthoides*) thistle, or both. Sampling consisted of

clipping five primary and five secondary seed heads from different thistle plants.

A primary seed head on *C. thoermeri* was defined as the terminal seed head on the main stem, or the terminal seed head from one of the top three branches. These three or four seed heads were the largest, earliest developing, and contained the most viable seeds on the plant (McCarty and Lamp 1982). Secondary heads were terminal seed heads on lower branches or lateral seed heads on any branch. These heads were typically smaller and developed later in the year.

The earliest appearing seed heads were sampled for *C. acanthoides*. This species flowers later in the year than *C. thoermeri*, and the seed heads tend to be uniform in size throughout the growing season.

The seed heads were dissected, and the numbers of RC larvae, pupae, and adults were recorded. A total of 81 sites was sampled and 925 seed heads dissected. Sampling began on June 14 and ended on July 27, 1988.

Impact of RC on thistles. In 1983, thirteen sites were selected for the release and evaluation of the impact of various biological control agents on thistles. Most of these sites were on the Interstate-70 right-of-way. However, it was not until 1986 that quantitative, comparable measurements were taken of the thistle populations located at nine of these sites. The sites were surveyed again in 1987 and 1989.

The surveys were conducted using a belt transect sampling method. Ten transects, each 15 m x 0.4 m, were made at eight of the sites, while 15 transects, each 10 m x 0.4 m, were used at one of the sites that was less than 15 m in width. All reproductive (bolting) stages of *C. thoermeri* and *C. acanthoides* were counted.

Results and Discussion

RC was present in those areas where *Carduus* thistles have been a problem for many years: Carroll, Frederick, and Washington Counties. In these counties, RC was present in large numbers, averaging 6.7, 15.2, and 15.5 weevils per primary head, respectively (Table 1). Secondary seed heads in these counties were also infested, as were the primary seed heads of *C. acanthoides*. In Frederick and Washington Counties, RC was consistently found at high levels on *Carduus* thistles. These two counties supported the highest populations of *Carduus* thistles (P. W. T., unpublished data). The distribution of RC in Carroll County was more spotty. This was probably a reflection of the lower density of thistle populations in the county. RC is known to favor areas where *C. thoermeri* populations are high (L. T. Kok, pers. comm. 1988). The reasons for this are unclear but, in the presence of a stable food supply, populations of RC can build to large numbers.

Table 1. Mean number ($\pm$ SD) of *Rhinocyllus conicus* found infesting primary and secondary seed heads of *Carduus thoermeri* and *C. acanthoides*.

County	Type ¹	N ²	Insects / seed head
Anne Arundel	M1	10	0.0 ($\pm$ 0.0)
	M2	5	0.0 ($\pm$ 0.0)
Baltimore	M1	25	2.4 ($\pm$ 1.4)
	M2	25	0.2 ($\pm$ 0.2)
Carroll	M1	85	6.8 ($\pm$ 4.2)
	M2	85	1.6 ($\pm$ 1.4)
	P1	5	1.4 ($\pm$ 2.2)
Frederick	M1	155	15.2 ($\pm$ 6.4)
	M2	155	4.8 ($\pm$ 2.5)
	P1	30	1.4 ($\pm$ 0.9)
Harford	M1	10	0.0 ($\pm$ 0.0)
	M2	10	0.0 ($\pm$ 0.0)
Howard	M1	5	0.0 ($\pm$ 0.0)
	M2	5	0.0 ($\pm$ 0.0)
	P1	5	3.4 ($\pm$ 1.7)
Prince George's	M1	5	0.2 ($\pm$ 0.4)
	M2	5	0.0 ($\pm$ 0.0)
Washington	M1	95	15.5 ($\pm$ 7.7)
	M2	95	4.9 ($\pm$ 4.2)
	P1	110	1.4 ($\pm$ 0.8)

¹ M1 = primary seed head, *C. thoermeri*. M2 = secondary seed head, *C. thoermeri*. P1 = earliest available seed head, *C. acanthoides*.

² Number of seed heads sampled.

As expected, those areas with scattered populations of *C. thoermeri* did not support large populations of RC. This was characteristic of parts of Carroll, Baltimore, Harford, Howard, Anne Arundel, and Prince George's Counties. Although populations of *C. thoermeri* in these counties were locally heavy in some cases, they frequently escaped attack by RC.

Another impediment to the establishment of RC in these areas may be a lack of sufficient "buffer" areas containing thistles which would not be affected by local control measures, such as the eradication of a small field infestation by herbicides.

Despite a general lack of synchronization with *C. acanthoides*, RC did attack this species. Rowe and Kok (1984) noted a delayed ovipositional period for RC in pure

stands of *C. acanthoides*, suggesting the development of a strain that can take advantage of this thistle species by shifting its activity to later in the year. If true, the same may occur in Maryland.

Impact of RC on thistles. The densities of the two thistle species fluctuated during the course of this study (Fig. 1). There were no obvious trends and no significant changes in the populations of *Carduus* thistle species at any site, despite the presence of RC. Also present at some of the sites were *Trichosirocalus horridus* (Panzer), a rosette feeding weevil, and *Cassida rubiginosa* (Muller), a leaf feeding beetle.

It is not known why the thistle populations, primarily *C. thoermeri*, did not decline. The most obvious reason is because data on thistle densities were not collected until 1986, eleven years after RC was released. The interval may have been sufficient for RC to reduce significantly the density of *C. thoermeri* to its present level, despite the fluctuations that were noted during this study. Kok and Surles (1975) found that RC reduced significantly the density of *C. thoermeri* four years after it was introduced.

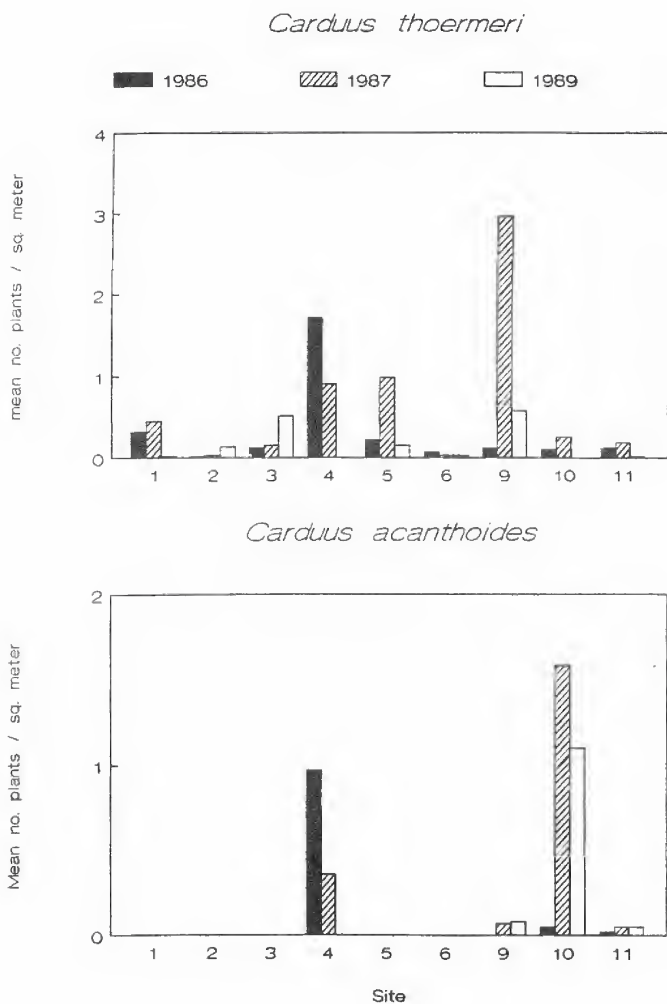
Another problem encountered at the sites was the interference caused by the routine mowing or spraying of the study areas. Annual broadcast treatments of broadleaf herbicides were applied to roadsides, usually killing the crown vetch, *Coronilla varia* L., that had been planted to control erosion. Often these areas were quickly colonized by thistles that persisted for several years until grasses became established. Those sites most severely disturbed by spraying were not included in the results.

Without pre-release information on thistle populations, it is impossible to document quantitatively the beneficial impact of RC in Maryland. However, the results in nearby Virginia, as well as in other states and countries, provide ample evidence of their efficacy.

In 1988, populations of RC in primary seed heads of *C. thoermeri* were high, with up to 45 weevils per head. Although no data were gathered on the number of viable seeds per plant remaining after RC attack, it appeared that a large portion of the most viable seed in the "thistle-belt" was destroyed in 1988. This conclusion is based on our observations and evidence provided by other researchers. Surles and Kok (1978), found that 6.8 weevils per seed head reduced the amount of seed by 75%. McCarty and Lamp (1982) found that an average of 2.3 and 11.5 weevils per seed head reduced the total number of the most viable seeds per plant by 28.2% and 77.9%, respectively.

RC is well established in the "thistle-belt" area of Maryland. The weevil destroys a large portion of the seed produced by *C. thoermeri*, as well as a smaller portion of *C. acanthoides* seed. However, there are still areas of the State with isolated but heavy populations of *C. thoermeri* that thus far have escaped attack by this weevil.

Fig. 1. Density of *Carduus thoermeri* and *C. acanthoides* at selected release sites in Central Maryland from 1986 to 1989.



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Cover illustration: The logo of the Maryland Entomological Society features the Maryland Shield and a specimen of *Euphydras phaeton* (Drury), the Baltimore checkerspot, which is the official insect of the state of Maryland.

The Maryland Entomologist is published irregularly by the Maryland Entomological Society. There are four numbers in each volume. Original articles on geographic and temporal distribution, particularly pertaining to Maryland and adjacent states, ecology, biology, morphology, genetics, systematics, behavior, etc. are welcome. Book notices and reviews, distributional notes, migration, life history, and others will be published. All articles are subject to editorial review and acceptance. They should be sent to: C. L. Staines, Jr., 3302 Decker Place, Edgewater, MD 21037. Instructions to authors are contained in Volume 3(2).

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